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DESCRIPTION OF THE MEAP PROFICIENCY SCALES

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Description of the MEAP Proficiency Scales

Massachusetts Educational Assessment Program
Massachusetts Department of Education

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INTRODUCTION

The Massachusetts Educational Assessment Program was established in 1985 with two purposes: to compare academic achievement among schools and districts and to give curriculum and instructional guidance. Biennially, it tests all students in grades four, eight and twelve in four academic subjects: reading, mathematics, science and social studies. Using a matrix sampling design, each student answers only a small proportion of the total number of multiple-choice questions that cover all aspects of the curriculum. In addition, a sample of students answer open-ended questions which require students to apply knowledge and understanding in different contexts. Students also respond to a series of questionnaires about their background, attitudes and school activities. Although the program obtains its information by testing students, it is not designed to give individual student results.

The scores which are used to report results to schools and districts are called **scaled scores**. These scores, in which the percentages of correct responses are statistically modified to conform to some common metric, were developed in order to make valid and accurate comparisons across schools and over time. When used in the school and district reports, they provide a measure of each school and district's achievement relative to that of every other school and district in the state. Such scores are considered to be the most appropriate way to report comparative data. Unfortunately, however, they have no inherent meaning in themselves.

Because scaled scores were designed for comparison purposes only, they give no information to schools about what students can actually do. This can foster misinterpretation for those who attempt to use these scores in program evaluation. For example, relative to the state as a whole, a school may receive a high score in chemistry even though its students answer few of the chemistry questions correctly. Although these students may be **perceived** to perform well in chemistry, their high score is due, not to their own achievement but to other students' **lack** of achievement. Conversely, a school's low score in literal comprehension may be primarily due to the fact that, in general, students across the state perform very well on questions that call for literal comprehension. When almost all questions are answered correctly, a single incorrect answer can affect a score more dramatically than when fewer are answered correctly.

In order to correct this inherent limitation of scaled scores, proficiency levels were developed. As their name implies, these levels describe students' performance at different points on a scale that is related, but not identical, to the MEAP school and district scale scores. In defining and reporting on these levels, the MEAP hopes to give schools, districts and the public a better description of what students know and understand about each subject area tested.

The scale which was used to define student proficiency ranged from 650 to 2150, with a standard deviation of 300 points. On this scale, four levels of proficiency are defined: 950, 1250, 1550, and 1850. Descriptions for each level were developed by committees of Massachusetts teachers who were presented with sets of MEAP test questions (both multiple-choice and open-ended) that were answered correctly by a substantial majority of the students at a given level, but were answered incorrectly by students at the next lower level. The committees reviewed these sets of questions in order to identify and describe the common skills that differentiated one set from another.

The behavior which is attributed to students at each proficiency level in no sense defines all that the student can do. Our descriptions are, necessarily, bound by the questions which were asked in the assessment. Obviously, they do not cover ALL the concepts, processes and skills that are typical of each subject. What we have done is to use the test items as a way of knowing the students. However, as in the case of knowing any individual, there are facets of thinking and behavior that become apparent only in certain situations or contexts. In the present enterprise, the text questions act as contexts. In attempting to broaden our understanding of the students at each level, we have supplemented this information by examining students' responses to the questionnaires. In general, however, we have grounded our inferences firmly to the information at hand. Finer interpretations of why students can and cannot perform at various levels is more appropriate to the classroom teacher, who deals directly with the individual student.

PERFORMANCE ACROSS SUBJECT AREAS

On pages four and five is a general description of students at each level. The graphs next to each level show the average percentage of students who have attained the skills that characterize this level and above. For example, across the three grade levels tested, almost all students (approximately 89 percent) have attained the skills that are typical of the 950 level. The remaining 11 percent have not, with fewer students reaching this level at the twelfth grade than at the other grades. The majority of students (57 percent) have reached the 1250 level of proficiency or above, while 43 percent remain below this cut-off point. The other two levels are represented by far fewer students. For example, only an average of 19 percent of students have reached the 1550 level and 5 percent have reached the 1850 level of proficiency. In reviewing these capsule descriptions of students at the various levels of proficiency, it is apparent that students at the same level in different grades are characterized in much the same manner. This does not mean that they perform in identical ways. The material that they were responding to was appropriate for their grade level and, therefore, differed. It was their approach to the material presented that was similar. For example, although twelfth grade students at the 950 level are reading longer passages of more sophisticated content than fourth grade students at the corresponding level of proficiency, both have a minimal understanding of the content at their respective levels. Similarly, the amount of detailed information possessed by 1850 students at all grades suggests an intellectual curiosity that extends far beyond the taught curriculum.

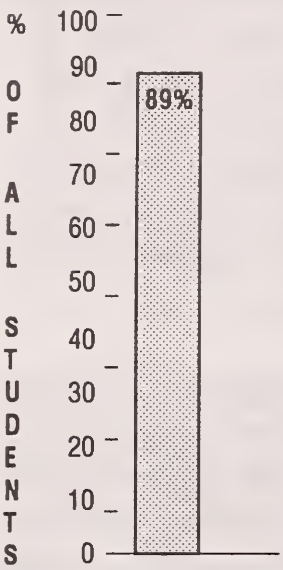
Although the styles of thinking that characterize each level are similar across grade levels, the types of skills and content knowledge differ. In some cases, such as reading, there is a steady progression in the length and complexity of the material which students understand. In others, such as science and social studies, questions that were answered correctly only by students at the 1550 or 1850 level in a lower grade were answered by students at the 1250 or 950 level at a higher grade. However, this does not necessarily imply that the fourth grader at the 1550 level is displaying the same skills and understanding as the twelfth grade student at the 950 level. The following may help to illustrate how the same question may require different abilities at different ages.

When changes occur very quickly in a country, there is often conflict because:

a. the changes were necessary.
b. the government has made careful plans to help people adjust.
c. no one obeys the new laws or follows the new ideas.
d. many people have difficulty adjusting quickly to new ways.

GRADE 4: 1550 level	GRADE 8: 1250 level	GRADE 12: 950 level
76% correct	71% correct	73% correct

The graphs next to each level show the average percentage of students who have attained the skills that characterize this level and above. For example, across the three grade levels tested, almost all students (approximately 89 percent) have attained the skills that are typical of the 950 level.



950 = Level I

GRADE FOUR

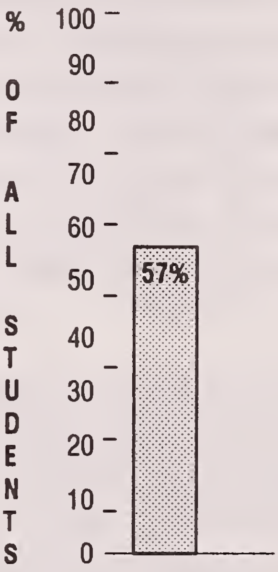
Students at this level are beginning to master the basic skills and concepts of the elementary school curriculum. They perform well when questions are set in contexts that they recognize as part of their experience and when material is presented visually.

GRADE EIGHT

Students at this level have mastered the skills and concepts of the elementary school curriculum; however, their understanding appears to be limited to the specific and practical. They perform best when questions are set in contexts that they recognize as part of their own experience.

GRADE TWELVE

Students at this level continue to perform best in a personal and practical context. They have acquired a set of academic skills that is useful in everyday life.



1250 = Level II

GRADE FOUR

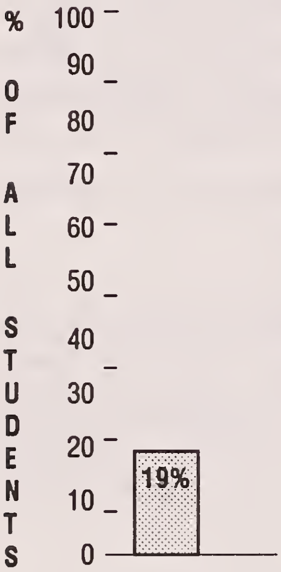
Students at this level are adept at the skills that constitute the main focus of the elementary school curriculum. Within familiar contexts, they show an ability to reason logically.

GRADE EIGHT

Students at this level have mastered much of the knowledge and skills that are typical of the taught curriculum. They are critical readers, evaluating material and recognizing assumptions. They are also adept at using visual material such as interpreting more advanced graphs, visualizing figures, and abstracting information from cartoons.

GRADE TWELVE

Students at this level show a greater maturity and a broader base of knowledge than eighth graders at the 1250 level; however, many of the characteristics of their thinking and some of their skills are comparable. In general, they are critical readers of text, but are less adept at integration and abstraction.



1550 = Level III

GRADE FOUR

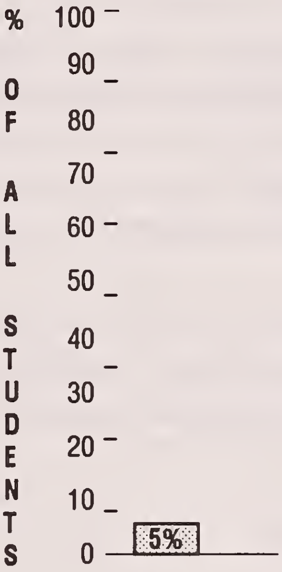
Students at this level are keen observers, paying attention to details. At the same time, they are beginning to think in terms of larger systems. This ability to recognize abstractions allows them the confidence and flexibility to reason through complex word problems, analyze content, and distinguish between necessary and irrelevant detail.

GRADE EIGHT

Students at this level think in terms of systems rather than discrete components. At the same time, they show a great attention to detail and a persistence in working through material. In addition, they are able to evaluate possible solutions by discriminating among nuances of meaning. They go beyond the taught curriculum to relate information from many sources.

GRADE TWELVE

Students at this level are primarily distinguished by their use of conceptual and logical analysis to solve problems. They also show a great attention to detail and can integrate information from the text itself, from other reading, and from their own experience in their construction of meaning. They possess a broad base of academic knowledge, both in history and in all major areas of science, and they are able to integrate and apply this knowledge to problem situations.



1850 = Level IV

GRADE FOUR

Students at this level have acquired a broad knowledge that goes beyond the taught curriculum and show an ability to use that knowledge as tools for logical analysis and reasoning.

GRADE EIGHT

Students at this level not only possess a broad base of detailed information about the subject areas tested, they are distinguished by their ability to analyze material and reason from it. Furthermore, in all areas, they possess an extensive vocabulary of technical terms that is appropriate to the subject.

GRADE TWELVE

Students at this level use a broad and detailed base of knowledge and understanding to solve problems and to construct meaning. They appear to have mastered all the elements of the secondary school curriculum in the subjects tested. They recognize the meaning of specialized terms in economics, as well as in other areas. Most striking is their independence in thinking.

For most students at grade four, the situation presented in this question is abstract and theoretical. Not only is the concept not explicitly taught, but the student must infer the answer from a limited knowledge of American or world history. The understanding of the concept of change shown by these fourth grade students reflects an ability to generalize from a limited set of examples. For twelfth graders, on the other hand, the response is more likely to represent factual information, knowledge that has been accumulated as a result of life experience or wider reading. The degree of generalization is far less abstract. Although, in both cases, the responses may indicate an understanding of the concept of change, the fourth graders who answered correctly are relying on critical appraisal and thoughtful reading to a far greater extent than their older schoolmates.

On the other hand, in mathematics, there is relatively little change in the skills and concepts which characterized eighth and twelfth grade students at the 1250 level. Although slightly more students at the twelfth grade are proficient with numerical procedures and basic algebraic ideas, the substance of the curriculum appears to remain the same. The items shown below, given at both grade levels, are examples of the kinds of thinking that is typical of these students.

If n is an odd number, which of the following is an odd number? *(answer: n + 2)*

Grade 8: 1250 level	Grade 12: 1250 level
66% correct	74% correct

☆ ☆ ☆

James and his friends were playing a game. Before his turn, James had 14 points. He lost 19 points during his turn. On his next turn, James won 7 points and lost 6 points. How many points does James have?

Grade 8: 1250 level	Grade 12: 1250 level
83% correct	91% correct

HOW TO VIEW THE PROFICIENCY LEVELS

The description for each level indicates what is particularly distinctive about students' performance at that level. By implication, it also indicates what students at the lower levels **cannot** do. For example, 91 percent of fourth graders can read simple passages, apply common sense to problems, and work with visual material (950 level of proficiency). Conversely, however, these figures indicate that 9 percent of the fourth graders have not reached this level.

Perhaps more informative is the next level (1250), which represents the majority of the student body. Whereas slightly more than half the students have attained the basic curriculum taught, the limitations of thinking on the part of these students is best illustrated by looking at what they **cannot** do, (i.e., examining the 1550 level of proficiency). Below are some examples that illustrate the difference between the 1250 and the 1550 levels of achievement in mathematics and science at grade twelve.

Why are most of the oldest life forms still living on earth found in the ocean?

Correct response: The undersea environment has been relatively stable over time.

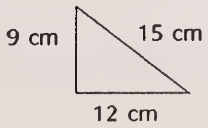
Correct at 1250 level: 41%

Correct at 1550 level: 78%

At the 1250 level slightly less that a quarter of the students believed that the oldest life forms are found in the ocean because salt water acts as a preservative. Slightly more suggested the reverse: that underwater life forms have changed more over time to adapt to their environment.

☆ ☆ ☆

What is the area of this right triangle?



Correct response: 54 cm^2

Correct at 1250 level: 23 %

Correct at 1550 level: 71%

This question does not require the knowledge of a computational formula. It requires the student to recognize that the figure given is one-half of a rectangle and, consequently, the area will be half the area of a rectangle with sides of 9 cm and 12 cm. A quarter of the twelfth grade students at the 1250 level multiplied all the numbers given; another 30 percent added them.

Both questions illustrate the tendency of the 1250 students to stay within the realm of the taught curriculum, particularly in the areas of mathematics and science. They find it difficult to apply their knowledge to problems which do not conform to those which they find in their textbooks or contain material other than that which has been explicitly taught.

HOW TO USE THE PROFICIENCY LEVELS

Percentages of students at each proficiency level, as well as the results for the district and the state as a whole, are given in the school reports. The purpose of these profiles of achievement is to help schools better interpret the scaled scores which they receive. The purpose of the detailed descriptions that make up the rest of this report is to give meaning to those profiles by describing specific skills, approaches, and understandings. By translating the proficiency levels into detailed descriptions of what students can and cannot do in the various subject areas, we hope to enable schools to address the specific needs of students more effectively. We also wish to emphasize the diversity of achievement that exists in any school and to help schools provide challenges for all students.

READING: GRADE FOUR

950

Students at this level are able to read simply written, relatively short narratives; to identify the setting of a story and the major story events; to follow directions; and to locate information that is contained within the text. They are able to draw upon their personal experience and common sense to answer questions outside the text and to make simple inferences.

Their vocabulary is limited to simple, commonly-used words, but they are adept at using contextual clues to recognize other words, provided that enough distinguishing features are presented.

HABBIES are animals that make good pets. Some HABBIES are mean, but most of them are friendly. HABBIES can bite, but most of the time they just bark. HABBIES are...(birds, cats, dogs, fish).

☆ ☆ ☆

Why is it a good idea to shoot [a basketball] with the hand you write with? (It is probably weaker, longer, bigger, stronger).

1250

Students at this level are able to deal with longer narrative passages of more complex style and subject matter than those at the previous level. Their greater competence in reading allows them to remember details and to make simple inferences that are dependent upon a literal interpretation of the text.

Typical of the material that they are able to handle is a long, rather involved story from a book entitled *Early Family Homes*, which described a pioneer family establishing a home in 1817. In responding to the items that accompanied the selection, these students were able to infer the author's purpose for writing the story (to teach the reader important facts) and to apply their background knowledge to construct meaning from the text.

Students at this level possess a more elaborate reading vocabulary than those at the 950 level, recognizing the correct definition of words such as "shanty" and "frustrated." However, they experience difficulty when words are used in a more figurative sense. For example, when the word "threatening" was used in reference to the sky, less than two-thirds of the students recognized its correct meaning.

Which line in paragraph 5 is the BEST clue to identify the season?

☆ ☆ ☆

The main purpose of the article is to...

1550

Students at this level are proficient in a broader range of reading materials than those at the previous levels. They are particularly adept in answering questions that are based on complex factual material and poetry. They appear to have achieved a level of skill that allows them to consider passages as a totality, rather than as a sequence of separate parts. They are able to recognize the author behind the text, showing an understanding of poetic devices and the poet's voice. The practical material which they handled well was complex, such as the rules for a game and a contest, demanding a close attention to detail, as well as analysis.

These students are also able to recognize figurative language and analogies. For example, they correctly identified the present day equivalent of a "Yankee peddler" and were able to understand the poetic use of *boulder* and *rock* as symbols for the passage of time. In contrast to students at the 1250 level, they held no uncertainty about the meaning of "threatening" when it referred to the sky.

Finally, students at this level are beginning to distance themselves from the text itself, becoming increasingly aware of themselves as readers. For example, when presented with an advertisement, students were able to identify the various techniques used to entice customers (including specific words, phrases, graphical devices). They are also able to identify appropriate reading strategies and to predict the type of material that an article would contain on the basis of its first few paragraphs.

Contest rules:

1. *The contest is open to all U.S. residents, regardless of their age.*
2. *All entries must be postmarked by April 30, 1988. Winner will be notified by mail.*
3. *Employees of Remarkable Robots and their families may not enter this contest.*
4. *Entries will be judged on a point system as follows:*

   50% — originality and imagination

   50% — presentation

Mr Q works for Remarkable Robots. Mr Q is married to Mrs R and they have two children, S and T. Mrs B lives next door with her children, C and D. Who can enter the contest?

1850

Students at this level do not differ a great deal from students at the 1550 level. Their reading ability is distinguished primarily, not by the type of reading material or by extent of comprehension, but by their ability to view the reading process *per se*. This is evident in their ability to identify appropriate self-checking questions and in their approach to the more stylistic aspects of poetry, where they appreciate the use and purpose of imagery and figurative language.

After reading paragraphs 12 through 15, what could you ask yourself to check your understanding?

☆ ☆ ☆

The poet describes the sun mainly by telling.......

GRADE EIGHT

950

Students at this level perform well when questions are based on high-interest informational passages and short narratives. Students are able to grasp the main idea of such passages and to locate information within the test or closely related to it. They are also able to distinguish between clearly demarcated facts and opinions and they can make simple inferences that are based on general information or common sense. For example, in the following examples, based on a chapter in a book on skateboarding, the first question does not rely upon the text itself, but can be answered from the common sense wisdom that checking equipment implies some aspect of safety. The second question asks for a general characterization of a selection from the passage. Again, close reading is not required.

> The minute you spend doing the 1,2,3 check could be the most valuable minute you spend in skateboarding because it might....
>
> ☆ ☆ ☆
>
> The suggestion in the "What to Wear" section emphasizes....

1250

Students at this level depend upon the literal aspects of the texts in order to answer questions, although they are able to make inferences about character and motivation. Furthermore, they can identify assumptions and to draw conclusions based on interpretations of different parts of the passage. They can differentiate among statements that hold similar meaning and can make judgments based on evidence presented in the passages. In keeping with their evaluative ability, they have a more sophisticated understanding of what constitutes an opinion, recognizing it as unsubstantiated factual material (in contrast to the student at the 950 level whose recognition was limited to hyperbole).

They are aware of some of the formal aspects of writing, such as the use of italics to emphasize important points and the purpose of footnotes.

In the first example below the student again answers questions based on the skateboarding book. It relies upon a close reading of the text in order to identify what is unstated. This is the kind of simple, text-bound inference that is typical of this level. The second question requires an appreciation of the formal aspects of writing and the need for clarity.

In writing the steps of the skateboard inspection, the author assumed the reader already knew....

☆ ☆ ☆

The author probably numbered the steps of the skateboard inspection because....

1550

Students at this level are able to go beyond the literal facts presented in the passages in order to construct meaning from the text. Using the written material as a scaffold, they can apply reasoning and their own experience to draw inferences. They are able to draw conclusions about the motivation of the characters in narrative passages and probable causes of events in more factual prose. Showing a careful reading and a memory for details, they are able to use the information presented to make inferences.

Students at this level are also able to distance themselves from the content and judge the craft of writing itself. They can recognize why a particular title was chosen, the functions of selected parts of a passage in contributing to the whole, and the purpose of certain format conventions. They are able to characterize the tone of a humorous fable and to identify different types of literature. The example below, referring to the same chapter from the book on skateboarding, requires the ability to recognize the purpose of the author in the writing the article, as well as an understanding of the conventions that usually apply in the presentation of material.

The title of the next chapter is probably....

☆ ☆ ☆

William Childress titles his poem "The Dreamer" because....

1850

Students at this level are distinguished from the previous level less by their reading comprehension than by their ability to reason and form judgements over a range of situations. Few of the responses which they identified correctly could be found within the text itself. Instead, most required abstracting meaning and then ideas, which were used as the basis for conclusions and inferences. Many questions required mature judgement and fine discriminations in meaning among of a set of plausible responses. Others required students to apply the ideas presented in the text to other contexts.

Whereas at previous level students responded correctly when vocabulary was presented in context, these students were distinguished by their ability to complete verbal analogies, which relied as much upon reasoning as it did upon vocabulary meaning.

Their level of understanding of the craft of writing is more sophisticated than that of students at the previous level. They show a familiarity with poetic forms, recognized irony, and stylistic devices.

The example below required the understanding of the word as it was used within the passage, the ability to apply the conditions to other situations, and the ability to distinguish between examples and non-examples. Although the word "quarantine" is embedded within the text, the question itself goes beyond passage comprehension to require conceptual and logical analysis.

Paragraph 13 mentions the *quarantine* imposed by California authorities. Which of the following situations would not be considered a *quarantine*?

a. Several students suffering from food poisoning are sent to the hospital where they remain under observation until their condition improves.

b. A person diagnosed as having a highly contagious disease is confined to an isolated area.

c. A state is not allowed to ship its fruit to other states because its orchards are infested with destructive fruit flies.

d. A pet dog remains under observation by customs officials for several weeks before being allowed to join its family in a foreign country.

GRADE TWELVE

950

Students at this level perform well on practical passages that are interesting and visually appealing and on narrative passages that deal with human relationships. Like the 950 level student at grade eight, they typically read for literal information. However, they can handle longer and more complex passages and, when presented with the same material, they can recognize complex ideas and associations, provided that they are contained within the text. When passages deal with social situations and human qualities, they can infer characters' motivations and feelings.

They show a basic familiarity with library skills, recognize the use of time-lines, and can use context clues to interpret such words as *manifest* meaning "to appear." Finally, they draw on their general knowledge to answer literary questions. For example, they indicated their familiarity with the use of serpents a symbols of evil when they correctly identified the character who was "the serpent" in another character's "Garden of Eden."

Why was the son glad to hear his father say .....?

☆ ☆ ☆

What can you do under the terms stated in the ad?

1250

Students at this level are able to read drier material (such as articles about history, sociology and current events) with understanding. They are able to summarize the main points of these articles and identify the writer's assumptions. They can use the information presented to interpret characters' points of view and predict their reactions to events. They can also interpret stylistically difficult written material which pose difficulties for student at the lower level. Unlike the students at the 950 level, their interpretations are not dependent upon a literal reading of the text.

In their role of readers, these students can recognize the purpose of visual aids, such as boldface, in clarifying the text. They also show more refined research skills, such as familiarity in using the *Reader's Guide to Periodical Literature*.

The example below illustrates the reading ability of students at this level. In order to recognize the assumption of the author, students needed: the concept of politics as an activity; an understanding of political cartoons as a form of art; the ability to recognize the conceit that politics acted as the food by which political cartoons were nourished. Although many students at the 950 level of proficiency did recognize the correct answer, approximately a third chose option c. In contrast, almost all students at the 1250 level answered the question correctly.

"Moreover, politics being politics, it is safe to *assume* that a rich source of targets assures the art a future without famine."

The writer's assumption is based on a belief that

a. people are fed up with political cartoons.
b. politics is boring because nothing new ever happens.
c. human tragedies such as famine should not be the subject of political cartoons.
d. politics will always provide targets for political cartoons.

1550

Students at this level show the result of reading in many areas. They comprehend a wide variety of material, including passages that contain complex ideas and detailed technical descriptions. In addition, they can relate information abstracted from the text itself, from other reading, and from their own experience in their construction of meaning. They show a sense of logical analysis.

They understand figurative language and can use the context of a passage to interpret words and phrases such as: *rank imitation*, *regressive tendencies*, *aluminum silicate*, *acquired taste*, and *taste aversion*. They can also complete difficult analogies that deal with concepts rather than actions or objects. For example: carpentry is to hammer as satire is to ...(symbolic, exaggeration, nails, tawdry).

As readers, they show a detailed familiarity with common reference books, identifying less commonly used features such as alternate spellings and etymology in a dictionary entry.

The differences in reading proficiency between students at this level and at the 1250 level may be illustrated by the type of questions they typically answered correctly. Both questions below were in reference to an article and a set of excerpts from observations of the Lowell mill conditions in the 19th century. The first two questions were answered successfully by the majority of the students at the 1250 level; the third was answered correctly by the majority of students at the 1550 level.

In order to answer the first two questions, students had to characterize the views taken by the various observers and generalize from them. Although they require the student to infer from the passage, these questions are rooted within the text. In contrast, the third question, answered particularly well by students at the 1550 level, required a broader understanding of the influence of audience on a writer. In order to answer this question, students had to use information contained in the entire section of reading. From this information, it was apparent that the conditions of the mill girls formed a focal point for political action. Students also had to understand how this political climate might affect the stance that the writer takes vis-a-vis his audience.

How are the views of Davy Crockett and Captain Hall similar?

☆ ☆ ☆

If you could ask each of the following people this question, "What were the working conditions like in the Lowell mills?," which individual would probably respond negatively?

☆ ☆ ☆

When Crockett says, "Not one expressed herself as tired of her employment, or oppressed with work," he is probably assuming readers...

a. are aware of the labor unrest among the workers
b. are not aware of the labor unrest among the workers
c. may be considering working in the mills
d. wouldn't be interested in reading about the working conditions.

1850

Although students at the 1550 level can comprehend scientific and technical passages of great detail and complexity, their primary skill involves constructing meaning from the text. At the 1850 level, students are able to deal with the reading passages as a totality, reflecting on the author's purpose and the techniques used to achieve that purpose. In other words, they are able to distance themselves from the meaning of the text to take into account the craft of writing itself. They appear to be cognizant of the explicit writing techniques and can recognize how they are being used.

The differences in types of responses among students at the 1250, 1550 and 1850 level can be compared with reference to the same passage, a detailed account of the history and scientific findings related to taste preference among humans. At the 1250 level, students correctly identified the main idea of the passage. At the 1550 level, they were able to distinguish between the various technical terms used and identify an example. At the 1850 level, students recognized the role of a thematic sentence in the passage as a generalization. Although the statement could be reasonably classified as both a fact and an opinion, in its context as the thematic proposition of the passage, it is used as a generalization, which is to be supported by evidence within the passage. This, more conceptual approach, distinguished between the approach of the students at the 1850 level and others at lower levels of proficiency.

The opening statement of this essay, "Everybody doesn't like something," best exemplifies...(a generalization; a fact; a conclusion; an opinion).

SCIENCE: GRADE FOUR

950

Students at this level are most successful with visual tasks and can interpret map symbols, order a visual sequence, and read simple graphs. They are familiar with those scientific facts that form part of common experiences or are the typical focus of children's literature and television. For example, they know that bears hibernate during the winter, that a frog's coloration acts as camouflage, and that magnets will pick up metal objects. Using their common sense, they apply a practical logic to experimental situations that are placed in simple, everyday contexts.

Sid has a large rock collection. He found another rock. What can he do to find out if he already has a rock of that kind? (compare; wait until he finds more; draw a picture of it)

1250

Students at this level are beginning to recognize some general order and regularity in the world about them. Their knowledge is not necessarily school-bound, but appears to come from many sources. For example, they are aware of growth rings in trees; they recognize the effect of gravity; they can classify living things; and they can identify simple changes of matter. Furthermore, they appear to understand the need for such scientific processes as observing and collecting data when conducting an experiment. When compared with students at the 950 level, they show a greater ability to apply their knowledge in evaluating information.

Which of the following could be most dangerous?

a. leaving an electric lamp turned on for more than 5 hours.
b. touching an electric cord where the covering is torn.
c. carrying flashlight batteries in your pocket.
d. turning on a light switch before plugging in the light.

1550

The knowledge level of students at this level is much broader than that of students at the 1250 level. Their responses to various questions suggest that they are keen observers, with attention to small but significant detail. In addition, these students go beyond a mere knowledge of scientific facts to show an understanding of the underlying concepts. For example, not only are they able to recognize various sense organs, but they show an understanding of their functions. Not only are they able to identify various phenomena, such as gravity or the reflection of light, but they are able to recognize their effects.

In some areas, the knowledge of fourth grade students at this level is comparable to those of eighth grade students at the 1250 level. For example, in response to the first question below, approximately 80% of both groups of students knew that a spacecraft used the most fuel in lifting out of the earth's orbit.

A spaceflight uses the greatest amount of fuel to...(escape the earth's gravity; orbit the earth; break out of orbit and fly to the moon; land on the moon).

☆ ☆ ☆

Which of the following are most important in helping our sense organs work together?...(nerves; muscles; blood vessels; food tube and windpipe).

1850

Students at this level possess scientific and practical information that goes beyond the taught curriculum. They are beginning to deal with more abstract concepts, such as evaporation and condensation; the role of erosion in land formation; and the relationship between plants and humans. They display a knowledge of vocabulary and essential facts, which they are able to assimilate and apply. In general, their broader knowledge and confidence allows them to use their reasoning skills to a greater extent than their peers at lower levels of proficiency.

The question below concerning atoms is typical of the kind of understanding that these students possess. Not only is the material itself beyond the typical curriculum, but the question demands an ability to recognize abstractions. Students had to formulate a relationship between two concepts: atoms and energy. Perhaps attracted by such terms as *atomic energy*, the majority of students at the 1550 level associated atoms with non-living things and chose *people* as the correct answer.

In contrast, 71% of the students at this level, recognizing the nature of matter, chose *energy* as the correct choice.

The second question, on plant decay, also poses an intellectual challenge for fourth grade students since most of the options given play some role the process of plant decay. For the student to choose *bacteria* she had to abstract and apply what is typically taught in relation to the human body to a different context. Eighty percent of the students at the 1850 level were able to do this, in contrast to students at the 1550 level, where almost a half chose *moisture* or *insects*.

All of the following except one are made up of atoms. Which one is NOT made up of atoms? (energy; people; gasoline; sodium chloride)

☆ ☆ ☆

Which of the following is most responsible for making a fallen tree decay and become an important part of the soil? (moisture; sunlight; insects; bacteria)

SCIENCE: GRADE EIGHT

950

Students at this level are aware of the scientific aspects of everyday life, such as nutrition and infection. They also possess some fundamental knowledge about the functioning of body system and classification of living things. When given a simple experimental situation, they are aware of such experimental procedures as the need for controls. In addition, they appear to be familiar with basic laboratory equipment (e.g., the balance).

In examining a patient, a doctor taps the patient's knee with a hammer to test the condition of which of the following? (the skeletal system; the circulatory system; the nervous system; the endocrine system)

☆ ☆ ☆

How do the heart and lung work together?

a. Movement of the lungs helps the heart to pump blood.

b. The lungs supply oxygen to the blood which the heart pumps throughout the body.

c. The heart and the lungs work together to help digest food.

1250

Students at this level can go beyond the everyday aspects of science to recognize instances of basic scientific concepts and to relate individual elements within a system. In the field of physical sciences, they can identify the practical effects of condensation and evaporation. In life sciences, they show an understanding of the inter-relationships within a system. For example, when presented with a more complex task than merely identifying an element within a food chain, they were able to predict the consequences to the system if one of its intermediary links were destroyed. When asked to apply their knowledge of plant biology to marine biology, they were able to recognize the relationship (see example below).

Scientific vocabulary is beginning to be recognized. Students can deal with longer, more complicated questions and can recognize the meaning of such terms as photosynthesis.

Students are familiar with scientific convention and with basic scientific skills in collecting and analyzing information. Given a set of data, they can identify the logical conclusion. They can recognize a situation in which the sampling of data is appropriate and can identify appropriate data gathering techniques for a particular research question. They also show a good understanding of the nature of science as a body of constantly evolving thought, subject to continuous modification.

In which part of the ocean is fish life most plentiful?

a. where the ocean is warmest
b. where the ocean is deepest
c. in the part of the ocean which is furthest from land
d. where there are the most plants and algae
e. where there are no sharks and other big fish to eat the little fish.

☆ ☆ ☆

If laundry hung out to dry is still damp after several hours, the presence of which of the following is most probably the explanation? (high humidity; some clouds; rising temperatures; brisk winds)

1550

Students at this level show a deeper understanding of scientific concepts by relating those concepts to a variety of situations that are different from the contexts in which they are taught. For example, they can explain why sunlight is not being used as a major source of energy; why bees are used for pollination of cranberries. Whereas students at the 1250 level are knowledgeable about many aspects of science that are part of the school curriculum, students at this level can make connections beyond what is explicitly taught. The qualitative difference in their ability to use scientific concepts is illustrated by their ability to apply what they know of biological science to an earth science situation. Although students at the 1250 level show that they are familiar with the inter-relationships within a system (see previous example), they were not able to transfer their knowledge to an unfamiliar context, as in the example below. This question was answered correctly by 68% of the 1550 level students and 36% of the students at the 1250 level.

Students at this level apply their analytic ability to experimental situations. They can draw conclusions based on a careful analysis of the data. They are able to judge different types of information that might be relevant in answering research questions. They recognize possible sources of experimental error. Given a set of observations, they draw reasonable inferences.

Which of the following best explains why marine algae are most often restricted to the top 100 meters in the ocean?

a. They have no roots to anchor them to the ocean floor.
b. They are photosynthetic and can live only where there is light.
c. The pressure is too great for them to survive below 100 meters.
d. The temperature of the top 100 meters of the ocean is ideal for them.

☆ ☆ ☆

The solid, liquid, and gaseous states of water differ in which of the following ways?

a. the number of protons per molecule
b. the number of electrons per molecule
c. the net charge on the individual molecules
d. the number of neutrons per individual molecule
e. the average speed with which the molecules are moving

1850

Students at this level have a great store of detailed information about science. In addition, they are able to see the relevance of that knowledge to a variety of situations. On their own, they can put together discrete bits of information from different sources. For example, whereas students at the 1550 level show that they understand that the speed of molecules is different in different states of matter (see example above), students at this level understand that pressure and volume are related and that the speed of molecules determines the number of molecules. Although this concept is explicitly taught at the high school level, at the eighth grade it shows an integration of understandings that depends upon both knowledge and reasoning ability.

Which of the following contains the most molecules of water if the pressure is the same in each case?

a. a cubic foot of steam
b. a cubic foot of liquid water
c. both would contain the same number of molecules

SCIENCE: GRADE TWELVE

950

Students at this level are familiar with basic scientific concepts (e.g., forms of matter, elements of a food web, the effect of air masses on weather). They are aware of the functions of different parts of the body and everyday aspects of health. They can recognize fundamental experimental principles and their application when these principles are presented in typical textbook examples. For example, they recognize classic demonstrations of scientific procedures such as the boiling water to remove salt and can cite the need for controls in an experiment.

As at the other grades, these students work well with visual material. They can place a series of pictures in sequence and can read a scale that does not require interpolation.

What causes most earthquakes?

a. the movement of plates of the earth's crust
b. the rotation of the earth on its axis
c. the moon's gravity
d. volcanic eruptions

1250

Students at this level have a broader-based knowledge of scientific concepts, particularly in the area of life science, and can answer questions that are typical of work in biology beyond the basic level. For example, they are familiar with basic genetic vocabulary, such as *dominant* and *recessive*, and with well-known examples of natural selection and adaptation. They do not show the same breadth of knowledge in the physical sciences.

Students at this level can analyze and interpret information rather than just recognize its accuracy. They can use and interpret functional graphs. They can evaluate a series of options for the one that is NOT true (in contrast to merely identifying the correct option) and can evaluate a series of plausible options. They can use their knowledge as a basis for reasoning beyond the basic facts. For example, whereas students at the 950 level know the cause of earthquakes (see previous example), students at the 1250 level can use this information to make inferences about the kind of place an earthquake would occur. Almost twice as many students at this level were able to make a reasonable connection than were students at the previous level.

Students' reply to a question regarding displacement as it is related to volume suggests some practical laboratory experience. They also show a more fundamental understanding of the nature of science than students at the lower level. For example, when asked for the best evidence of the validity of scientific findings, students recognized the importance of verification in scientific experiments. The majority of students at the 950 level, possibly referring to their own experience, answered that the level of detail in lab reports was most important.

Areas on the earth's surface which lie above the places where two plates meet are characterized by:

a. frequent earthquake activity.
b. lengthy formations of sea arches.
c. stable temperate climate conditions.
d. a lack of plant and animal life.

1550

Students at this level display a knowledge of basic information in the physics, chemistry and earth science curriculum. For example, they show a recognition of basic optics; they can explain chemical changes in terms of the activity of electrons; they recognize the chemical composition of water and the composition of the earth's atmosphere.

On the other hand, what is most evident about these students is their ability to analyze questions in a finer level of detail, to evaluate and to apply reasoning skills. This is apparent both in their responses to process-type questions involving experimental design and analysis and to questions based on the application of content knowledge. For example,with reference to the question below, in earth science classes the atmosphere is commonly compared to a shell of gases. A third of the students at the 1250 level chose this response, while another 22 percent were clearly wrong, believing that the atmosphere gets denser further away from earth. Students at the 1550 level understood both the relative density of the atmosphere and the fact that the atmospheric shell is not *uniform* throughout.

Which statement most accurately describes the earth's atmosphere?

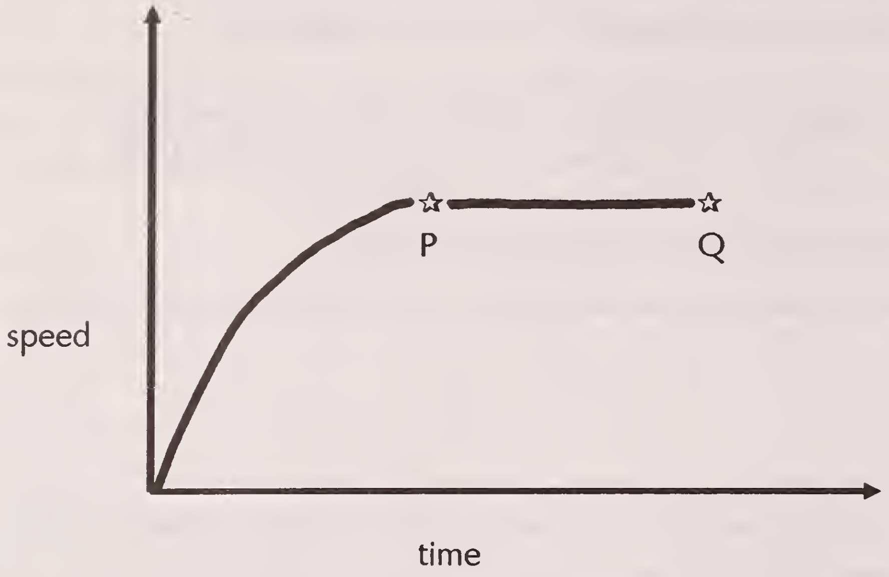
a. The atmosphere is layered, with each layer having certain characteristics.
b. The atmosphere is a uniform shell of gases surrounding most of the earth.
c. The atmosphere's altitude is less than the depth of the ocean.
d. The atmosphere gets denser further away from the earth.

1850

Students at this level show a broader knowledge and a deeper understanding of science topics over many subject areas. They can classify examples of physical and chemical change. They display an understanding of process of respiration and the function of pulmonary veins and arteries. They can reason about the cause of seasonal changes, recognizing the relative effects of the earth's rotation and tilt. They are familiar with a classic example of evaporation. In contrast to students at the 1550 level, they understand that rock classification is based upon rock origin rather than upon their composition.

Whereas students at the 1250 level recognized a graphical representation of equilibrium when placed in the context of a population growth curve, students at this level recognized it in the context of physics (see below). The fact that the familiarity of material presented in a graph is a strong factor in whether or not we can interpret it suggests that students needed some understanding of acceleration and gravity to recognize the significance of the slope.

This ability to grasp more complex scientific principles and to apply them in experimental and practical contexts is typical of students at this level. For example, in response to the classical pendulum problem that, for Piaget, indicated formal thinking, these students were able to identify the necessary and sufficient set of variables to identify the effects of the time it takes for the pendulum to complete a swing. Although this kind of thinking indicates a high level of abstraction, it must be anchored in an understanding of the concepts involved.



The graph above indicates the speed of a sky diver during the free-fall period of a jump. Which of the following statements can be made concerning the skydiver's motion from point P to point Q?

a. The skydiver is undergoing positive acceleration at a constant rate.
b. The sum of the upward and downward forces acting on the skydiver is zero.
c. Each second the sky diver drops another 9.8 meters.
d. The skydiver is undergoing negative acceleration at a constant rate.

SOCIAL STUDIES: GRADE FOUR

950

Students at this level perform well when tasks are presented visually. They can use simple keys to maps, read graphs and maps, and can combine information. Aided by a picture they can recognize similarities and difference. However, written material presents comprehension problems due,in part, to the limited vocabulary of these students. For example, students at this level could not answer questions that depended upon an understanding of such words as *rabbi* and *Amish*.

Although these students have a store of general knowledge and common sense which they can apply to situations. They appear to have limited information about the larger world or of societies that differ from their own; and classroom experience does not appear to remediate this lack of knowledge.

John wants to show his friend the way he walks to school. Which ONE would be the BEST to use? (a map of John's town; a map of John's state; a map of the world; a globe)

1250

Students at this level appear to have grasped the basic content presented in the elementary social studies curriculum and show an awareness of the world about them. In contrast to students at the previous level, they can classify people according to their roles; they have some knowledge of groups within the American culture; and they show an understanding of certain economic concepts. In addition, they have some basic knowledge of the process of research, such as the need to collect information.

They have begun to reason about information. For example, they can distinguish between fact and stereotypical statements of opinion, and they can complete such tasks as placing a set of historical pictures in chronological order.

PRIEST, RABBI, MINISTER

The main job of all the people listed above is to

a. carry out religious duties.
b. work in government.
c. protect animals and nature.
d. travel to different countries.

1550

Students at this level are more aware of community, levels of government, and cultural diversity than those at the previous one. They have a sense of the past, recognizing a sequence of important historical events. They also show an understanding of certain major concepts, such as the concepts of change, need vs. wants, and cause and effect. In addition, these students are distinguished by their ability to evaluate information and to make judgments, identifying the best response among a set of plausible ones.

Whereas, at the lower levels, students show a basic understanding of the research process, these students are able to go beyond this to recognize the varying requirements of different types of research questions. (example)

Finally, their map and graphing skills are well-developed. They can interpret and use coordinates and, using a map, can produce a clear and precise set of directions.

What would be the BEST way to find out how your neighbors feel about a power plant that is going to be built near your house:

a. Interview a group of your neighbors.
b. Read newspaper articles about the power plant.
c. Ask the town librarian about the power plant.
d. Talk to someone who works at a power plant.

1850

Students at this level show clear reasoning ability: inferring from data, recognizing assumptions, and justifying their responses. Their knowledge of history goes beyond the recognition of benchmark dates or events to indicate a deeper understanding of some underlying historical currents, as well as a sense of time. For example, in response to a question on the purpose for Columbus's exploration, they replied at a manner comparable to eighth grade students at the 1550 level of proficiency. At the fourth grade, this type of question measures students' ability to go beyond the taught facts of the curriculum. By differentiating between the underlying concerns of the age of exploration and the age of colonialization, students at this level displayed a clear sense of the passage of time.

Students at this level also show an awareness of current issues and are able to relate such issues to their own behavior. For example, when asked to suggest actions that would help to conserve natural resources, their responses were specific and personal, such as turning off water and taking shorter showers. In contrast, students at the other levels tended to give more general and stereotypical measures (conservation, recycle).

Which one of the following tells why Christopher Columbus first sailed westward from Europe?

a. to trade with Africa
b. to start a colony in the New World
c. to find a water route to India or Asia
d. to bring religion to the natives of the New World
e. I don't know.

GRADE 4: 1850	GRADE 8:1550
81% correct	78% correct

GRADE EIGHT

950

Students at this level show good map skills in the use and interpretation of complex maps. They can respond to passages which require the basic knowledge that is presented as part of the typical eighth grade curriculum (e.g., citizenship and personal rights). They are familiar with American statesmen, such as Martin Luther King, and recognize the purpose of major legislative programs such as social security. On the other hand, they have difficulty inferring beyond the text, applying their knowledge to specific contexts, and discriminating between several plausible responses. The knowledge appears to remain at the most general level and their judgment is basically in terms of absolutes.

Generally the law does not allow the police to search somebody's house without written permission from a judge. Why do we have this law?

1250

Students at this level display a general knowledge about the world beyond the classroom, correctly answering questions dealing with the environment, current events, and World War II. They show retention and understanding of the taught curriculum. For example, they are able to differentiate between the principles contained in the Constitution and the Declaration of Independence. They also show an understanding of certain fundamental concepts, such as change.

These students perform well with visual material. They can infer information from graphs and identify the message carried by political cartoons. They also show a familiarity with place geography, successfully locating the geographical position of cities and states within the United States.

In terms of critical processes, they can discriminate among a set of plausible options, can distinguish between fact and opinion, and can generalize correctly from a set of facts.

Mosques, temples, and synagogues are all examples of....

☆ ☆ ☆

Students were given a set of facts about three countries (i.e., type of soil, location, growing season, source of food). They were then asked to choose the best generalization from the following set of statements:

a. Geography is an important factor in how people live and work.
b. Most people farm for a living when soil is fertile.
c. Countries with enough fertile soil do not have to import food.
d. Most people fish when soils are poor.

1550

Students at this level are able to go beyond the facts and taught definitions of the curriculum to recognize the underlying concepts. In fact, it is the depth of their understanding of important concepts that most clearly distinguishes these students. They are also distinguished by their ability to reason. As was the case with the students at the 1250 level, they were able to judge generalizations from a set of statements; however, the context of the generalizations at this level was more abstract. They are able to interpret statements and to spot lapses in logic and consistency. They also show a knowledge and sophistication in the use of research techniques and in differentiating between primary and secondary sources of information.

Students at this level are fluent readers, handling difficult vocabulary, and showing a degree of persistence and attention to detail that is lacking at the previous levels. For example, they were able to extract information from a complicated charts in order to verify a set of statements. They were also able to interpret and integrate information presented in two graphs and use their interpretation to make reasonable predictions. Likewise, they could identify the characters presented in a cartoon and recognize the main idea.

Which of the generalizations listed below can best be made from the following facts about ancient Athens?

1. Slave labor was an important feature of the economy.
2. Women could not vote in elections.

a. The ideas about democracy have been expanded in modern American society compared to ancient Athens.

b. Most ancient cultures developed democratic systems of government.

c. Athens was the center of a great civilization.

d. Athenian citizenship was granted to all inhabitants.

* * *

Which of the following best explains the meaning of "democracy"?

a. Citizens participate either directly or indirectly in the governing process.
b. The government consists of executive, judicial, and legislative branches.
c. Powers are divided between the state and federal governments.
d. The government controls business and industry.

1850

Students at this level possess a store of detailed information about present and past societies, as well as a wide vocabulary, including such technical terms as *scapegoating* and *lobbying*. Beyond this, however, they are able to recognize the relevance of this knowledge to specific contexts. For example, the question below not only calls for a knowledge of the formula for representation to Congress, but it demands the ability to think of examples or to reason logically.

Although the extent of their knowledge base extends far beyond the typical social studies curriculum, these students show an accurate perception of what has been taught. Whereas, for example, students at the lower levels of proficiency appear to accept the popular myth that Abraham Lincoln's goal at the start of the Civil War was to free the slaves, these students understand it to have been the preservation of the Union.

These students are careful, thoughtful readers, paying attention to significant details and tone of voice that shade meaning. Consequently, they are able to evaluate statements and to recognize examples of assumptions and bias. They are also thoughtful writers, as was evident in their responses to the open-ended questions to which they produced well-developed and reasoned responses.

When might a state have more senators than it has representatives?

☆ ☆ ☆

Suppose the following statements were made by an American labor union official. Which of the statements is **not** an example of a cultural bias?

a. The American people are, on the whole, happier than Russians.

b. Only the American people have the moral strength to resist communism.

c. Measured by material wealth, America has a higher standard of living than the Soviet Union.

d. The American worker is more devoted to his job than the Russian.

GRADE TWELVE

950

Students at this level have accumulated a store of knowledge about the history and structure of society and are able to use it in reasoning about real-life situations. Whereas with the younger students, we used the phrase *common sense* to describe the basis for their reasoning at this proficiency level, for twelfth graders, *life experience* may be more appropriate. In addition, students at this level have a set of practical skills that are useful in life. They are able to read and interpret graphical information when it is presented in familiar formats (e.g., bar graphs) and they display a knowledge of place geography.

They can differentiate among levels of government, have a good command of personal rights, and can distinguish between different types of political actions (e.g., peaceful resistance in contrast to resistance which violates the rights of others). In practical situations, students are able to use their school knowledge to make inferences that go beyond the curriculum. For instance, in the example below, students not only had to be aware of Iceland's geographic position relative to other countries, but they had to recognize how this factor contributed to a lack of cultural diffusion, including language.

Compared to the languages of most European countries, the language of Iceland has changed very little over time because Iceland has...

a. had close contacts with other people and activities.

b. been settled only recently.

c. been relatively isolated from other people and places.

d. maintained a higher literacy rate than other countries.

1250

Students at this level display the ability to interpret, to interpolate, and to evaluate the material presented. Given a set of statements, they are able to identify the logical conclusion among several plausible distractors. Questions that distinguished their performance required an attention to detail, as well as the ability to recognize a point of view and to apply their understanding in contexts that do not form part of the standard curriculum. The item below illustrates these kinds of skills. In contrast to students at the lower proficiency level, who chose at random among one of the three historically correct passages, the response of students at the 1250 level suggests that they carefully read the passage, evaluated the various plausible options, and were able to judge the one that most clearly reflected the author's point of view.

In addition, these students show an awareness of current events and factual modern history, as well as a knowledge of fundamental civic concepts such as representative democracy.

Finally, their responses suggest that they have a good mental map of cities and continents. When asked to do so, they not only able to identify different cities and land forms but they are able to relate them vis-a-vis one another.

Although many of the early colonists came to the New World to escape religious persecution, almost every colonial settlement along the Eastern seaboard set up rigid standards of religious conformity [everybody practicing the same religion]. Only the colonies of Rhode Island and Pennsylvania supported religious freedom. Even today remnants of earlier intolerance can be seen in American life.

From the writer's twentieth-century point of view, it is surprising that religious conformity was required in most colonies because

a. some colonies actually supported religious freedom.

b. most colonists had the same religion.

c. groups that insisted on religious conformity had fled from similar conditions in Europe.

d. those who enforced conformity were not very religious themselves.

1550

Students at this level show a broad knowledge of current events and modern history, as well as a knowledge of ancient civilizations. They are also familiar with specialized social studies vocabulary, such as *embargo* and *boycott*, and with economic concepts, such as the characteristics of American capitalism. More important, perhaps, they are able to integrate this information in response to specific situations. In response to the open-ended questions, in particular, they showed their ability to marshall information from many sources to produce a well-developed reply.

They are well-versed in government structure, making fine distinctions about the powers and responsibilities of different branches of government. In addition, they show an appreciation of the realities of American political practices. For example, 80% of these students recognized that the choice of a vice-presidential candidate was primarily governed by the need for the party ticket to appeal to voters.

They were able to recognize detailed but vital information in unfamiliar graphical format. Presented with two graphs based on different sized populations, they were able to integrate the information and interpret their meaning. They were also able to use the information to project future events. They displayed the same level of understanding when presented with political cartoons, identifying the characters portrayed and relating them to current political events.

They are able to evaluate statements and distinguish between nuances of meaning, and they can apply this evaluative ability in different contexts. For example, the following research question was answered correctly by 71% of these students. Whereas students at lower levels believed that photographs and numbers (election results) were most unbiased (presumably because of their objectivity), students at this level probed deeper. They looked at a more critical characteristic of evidence, the source itself, when making their judgements of validity.

Which of the following would give you the most unbiased information on how a new government came to power?

a. photographs taken by government leaders
b. election results released by the government
c. interviews with political prisoners
d. reports written by United Nation observers

1850

Students at this level are primarily distinguished by their detailed knowledge of history and governmental processes. For example, they were aware that Germany had to give up its colonies after the First World War; they understood the legislative sequence for a bill to become law. They recognized the meaning of specialized economic terms, such as *opportunity costs*. In responding to questions, they are thoughtful readers, rejecting stereotypical thinking in their appraisal of possible responses. Instead, they used their knowledge to reason and infer, as when they correctly accounted for Brazil's lack of alliance with other South American countries.

Their ability to use information from different sources was apparent both in their responses to open-ended questions which required a reasoned argument and in their responses to the multiple-choice. An example of their reasoning in geography is included below. Not only were students required to understand what the terms *longitude* and *latitude* mean (as opposed to using them as a location tool), but they had to infer their climatic influences. Likewise, given a map without identifying names, these students were able to identify two countries of strikingly different size and geographical position that, nevertheless, shared the same standard of living. The ability to answer this type of question requires, not only the ability to recognize the shape and position of different countries and an understanding of climatic factors, but knowledge of their economy.

Brazil has never strongly allied itself with other South American countries because

a. Brazil has few natural resources.
b. its government is communist.
c. Brazil has no formal religions.
d. its people speak Portuguese.

☆ ☆ ☆

The table below gives the latitude and longitude of five places which are assumed to be at the same altitude. Use the information given in the table to answer the question below it.

Place	Latitude	Longitude
A	2° N	65° W
B	46° S	171° E
C	42° N	83° W
D	48° N	14° E
E	30° S	31° E

Which of the five places probably has the warmest climate?

MATH: GRADE FOUR

950

Students at this level are most successful with visual material. For example, not only can they read a simple scale when it involves counting or recognition, but they can use visual material to reason mathematically. When problems are presented in a practical context, with illustrations, they are able to go beyond the simple recognition of facts. These students are also proficient in using basic number concepts (e.g., rounding) and operations (e.g., subtraction with borrowing) and can ignore irrelevant information to answer simple word problems that are set in familiar contexts.

One rabbit eats 2 pounds of food each week. There are 52 weeks in a year. How much food will 5 rabbits eat in one week?

1250

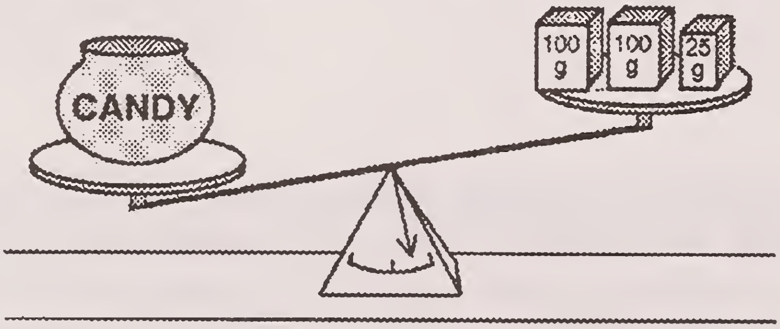
Students at this level are not as dependent upon the concrete support as students at the earlier level. They can solve one-step word problems requiring multiplication or division, and multi-step problems that involve addition and subtraction. They show an ability to reason about numbers. In contrast to students at the 950 level, they can not only read scales and graphs, but they can interpolate, interpret, and compare the information presented. These students also show a good sense of number operations. They can translate situations, both verbal and visual, into number expressions and sentences and can work with simple decimal operations.

Sam has 68 baseball cards. Rosa has 127. Which number sentence could be used to find how many more cards Rosa has than Sam?

1550

Students at this level no longer see number as a property of a collection of objects, but are beginning to exhibit an understanding of number as a variable. Furthermore, they seem confident in their ability to work with numbers *per se*. For example, these students recognize sequences, patterns, and functions that are dependent upon single operations (e.g. + 6; x 3). When aided by a visual example, they can solve simple combinatorial problems, such as combinations of shirts and slacks. They can also solve simple equalities and can estimate, using a variable in a number sentence. They are willing to attack verbally complex word problems by analyzing their content and distinguishing between necessary and irrelevant information.

Their approach is orderly. For example, they are able to organize a set of data into an accurately drawn histogram. They also show a visual sense and an ability to make simple transformations of shapes. In more traditional terms, they are able to compare the relative size of simple (unit) fractions and can use a drawing of a clock to calculate the passage of time.



What is the weight of this bag of candy?

a. 225 g
b. more than 225 g
c. less than 225 g
d. I don't know

1850

In general, the abilities that characterize these students are not computational but intellectual. They show an understanding of the relationship between numbers and quantities, pay close attention to detail, and can apply mathematical reasoning skills to a variety of problems. They are neither distracted nor discouraged by unfamiliar and complex formats but are able to recognize the essential features of a problem.

In response to the first problem shown below, students at the lower levels of proficiency consistently chose as incorrect one of the two options that were not symmetrical. It was only at the 1850 level that the majority (73%) were able to analyze the difference among the options and to recognize that subtraction is not commutative.

Students at this level also know the meaning of simple mathematical symbols, as in the second example below. Whereas only 46% of the students at the 1550 level (and almost none at the other levels) recognized the meaning of the sign, 91% of the students at this level answered the question correctly. These students are also familiar with basic statistical concepts such as measures of central tendency and are able to apply logical analysis to the interpretation of graphs.

Which number sentence below is NOT true?

a. $325 + 47 + 13 = 60 + 325$
b. $247 - 159 = 159 - 247$
c. $13 \times 8 \times 6 = 13 \times 48$
d. $465 + 169 = 169 + 465$

☆ ☆ ☆

$5 + \square < 12$

Which number(s) below can go in the ☐ to make this number sentence true?

MATH: GRADE EIGHT

950

Students at this level are proficient at the skills that characterize the typical fourth grade curriculum. They can successfully carrying out operations with whole numbers, round whole numbers, subtract fractions with common denominators, and translate simple word problems into number sentences. They are familiar with some geometric terms (e.g., diameter); can identify plane figures (e.g., a cylinder); and can recognize the similarity of various figures. Finally, they can also read information contained in histograms.

> Some coins were in a jar. Lee put 73 more coins in the jar. Now there are 182 coins in the jar. Which number sentence describes this story?

1250

Students at this level have a basic understanding of the numerical skills and concepts that form the basis of the elementary school curriculum. They are proficient in carrying out numerical operations of whole numbers, decimals and fractions, whether these are presented as computation or within a problem setting. They are able to compute averages and can solve simple problems involving integers. They show an implicit recognition of the distributive and commutative properties of numbers when they are in a specific numerical context, such as: $8 \times (3 + 2) = (8 \times 3) + (8 \times 2)$.

These students can also work with more complex visual material. They can go beyond reading simple histograms to interpret line graphs, interpolating and comparing information. They recognize fractional parts, whether presented as a part of the whole or as a collection of items within a larger set. They show a basic sense of geometry, visualizing the shape that would result from a set of conditions, such as a set of points that are equidistant from the center. Finally, they can recognize variables, evaluate an expression, and use formulas. This suggests that they are beginning to have the skills necessary for algebra.

Debbie runs .6 of a mile every day. How many miles will Debbie run in 45 days?

☆ ☆ ☆

If $x = 3$ and $y = 5$, what does $3x + 4y$ equal?

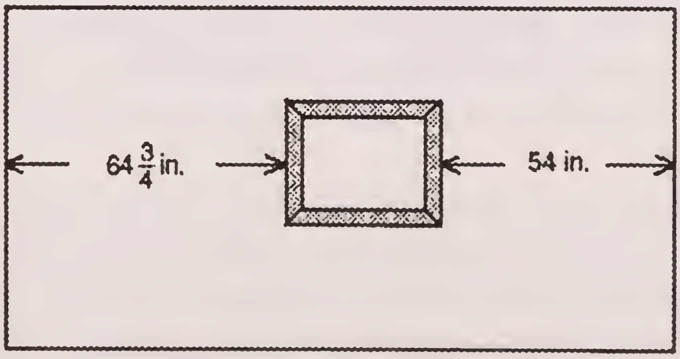
1550

Students at this level have a thorough knowledge of numerical operations and some understanding of more complex numerical concepts, such as decimals, square roots and percentages. This proficiency allows them to solve two-step word problems that require these concepts. Beyond this, it appears to give them the confidence to tackle problems that are as dependent upon reasoning as they are upon computational proficiency. These students are able to recognize the essential features of such problems and to apply the necessary logic for solving them.

They are also familiar with the less traditional topics of the eighth grade curriculum. For example, they show a good grasp of the concept of probability, such as the notion of certainty. They recognize the use of variables and are generally more sophisticated in their use of symbolic language than students at the 1250 level of proficiency.

Suppose you had 10 coins and have at least one each of a quarter, a dime, a nickel, and a penny. What is the least amount of money you could have?

☆ ☆ ☆



The picture is not centered on the wall above. How far to the left should it be moved to be properly centered?

1850

Students at this level display detailed knowledge of mathematical terms and procedures in a wide range of topics. For example, they can express numbers in scientific notation and can decompose a square root (e.g., $\sqrt{36} = \sqrt{4} \times \sqrt{9}$). They know the necessary attributes for such figures as parallelograms and similar triangles. They can recognize lines of symmetry in a set of plane figures and can distinguish between integers and rationals. Whereas students at the lower levels implicitly recognize the properties of numbers, students at this level can identify the actual terms. Their understanding of these mathematical algorithms and concepts goes beyond recognition to suggest a much deeper level of understanding, as the computational example below suggests. Far fewer students at the 1550 level were able to look beyond the format ("there should be a decimal point") to recognize the fundamental effect of multiplying by a fractional number.

On the other hand, the abilities of these students are not limited to their more wide-ranging knowledge of mathematical topics. When presented with complex word problems, students at this level are able to recognize and apply a variety of strategies for solution. Whereas students at the 1550 level apply logical reasoning in their approach to problems, at this level students have the additional advantage of an ability to reason proportionally.

Please check the answer to the computation below by examining its reasonableness. Do not perform the computation. Instead, give reasons why you think it is wrong.

$$54 \times 0.7 = 378$$

response type	% responding level 1550	% responding level 1850
"multiplying by a decimal reduces the size of the number"	4	19
any answer showing estimation	4	20
"there should be a decimal point"	48	40

MATH: GRADE TWELVE

950

Students at this level have a basic sense of number, including the rounding of numbers and the addition and subtraction of integers. They can solve simple word problems that require fairly straight forward computation.

They perform well when problems are presented visually, are able to use coordinates to locate information, and can read and compare information contained in charts. In addition, they can also perform simple substitutions that are similar to those performed by 1250 level students at grade 8.

If $x = 3$ and $y = 5$, what does $3x + 4y$ equal?

GRADE 8: 1250 Level	GRADE 12: 950 Level
79% correct	70% correct

1250

Students at this level are adept at using basic operations on whole numbers, integers and fractions. This implies an ability to find the least common denominator and to convert mixed numbers. They can also recognize and apply these operations in simple practical problems. They are able to convert units within a measurement system and can use a scale to calculate distance. They show some familiarity with basic algebraic operations, such as solving for an unknown in a simple equation.

The abilities that distinguish students at this level from those at the 950 level are similar to those displayed by eighth grade students at the 1250 level. Both eighth and twelfth grade students at this level have some familiarity with symbols; they can visualize a plane figure, given the necessary conditions; they have a sense of integers. Although more twelfth graders were successful in responding to questions, the type of skills demanded was the same for both grades.

James and his friends were playing a game. Before his turn, James had 14 points. He lost 19 points during his turn. On his next turn, James won 7 points and lost 6 points. How many points does James have?

GRADE 8: 1250 Level	GRADE 12: 1250 Level
83% correct	91% correct

1550

Students at this level show a mature understanding of mathematical concepts and an ability to relate and apply them to problem situations.

They deal best with two types of problems. One set is characterized by its complexity. It consists of difficult situations which require close attention to detail and the application of geometric knowledge or algebraic manipulation. The other set consists of abstractions of mathematical concepts. This set requires a recognition of the concept involved, as well as an ability to reason in abstractions. Although some of the items that these students answered particularly well concerned topics that had been taught as early at eighth grade, these twelfth graders showed an understanding that seems to be lacking at the earlier grade or with other twelfth grade students at lower levels of proficiency.

On Monday a TV set was priced at $100.00. On Tuesday the store marked the price down 40%. By Thursday the TV had not sold so the price was marked down 40% of Tuesday's price. What was the sale price on Thursday?

☆ ☆ ☆

Larry says that $n^2 \geq n$ for all real numbers. Of the following, which value of n shows the statement to be false?

(- 1/2; 0; 1/10; 1)

1850

Students at this level can analyze their school-based knowledge and apply it in unfamiliar contexts. For example, their understanding of geometric concepts, such as similarity, extends beyond its application to plane figures and includes three-dimensional shapes. Their ability to work with percentages extends to include calculations with fractional percentages. Not only can they compute averages, but they can recognize the effect that different numbers exert on that computation. They also show a familiarity with number theory. Their proficiency in some areas, such as identifying and interpreting slopes and rationalizing the denominator of an exponent, reflects the advanced algebra curriculum. However, these students also solve complex word problems that cannot be easily translated into simple algebraic equations and are not typical of those found in textbooks. This deeper understanding of concepts and flexibility with problem solving possibly reflects an exposure to contest settings in which they are expected to apply divergent thinking strategies.

Millie buys a refrigerator for $315.00 and makes a $75.00 down payment. If she pays $21.80 a month for 12 months, how much is the total finance charge?

☆ ☆ ☆

A solid plastic cube with edges 1 centimeter long weighs 1 gram. How much will a solid cube of the same plastic weigh if each edge is 2 centimeters long?

☆ ☆ ☆

Edith has an average (mean) score of 90 on five tests. What score does she need on the next test to raise her average to 91?

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